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An Approach Towards Near-Field Communication (NFC) with Light Fidelity (Li-Fi)

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Abstract

Near-field communication (NFC), a short-range wireless connectivity technology is being increasingly adopted in both consumer and professional electronics and particularly for integrating mobile devices as a means of exchanging digital content globally. NFC began in the payment-card industry and is evolving to include applications in numerous industries worldwide. In recent years, a new technology termed Light fidelity (Li-Fi) came into the picture which uses visible light as a source of communication. Light fidelity (Li-Fi) technology is a wireless communication system that utilizes visible light spectrum to transmit data in a high speed and secure manner compared to the traditional Wireless Fidelity (Wi-Fi) architecture [5]. This paper presents that the concept of NFC technology can be achieved through Light fidelity (Li-Fi) technology by using the flashlight of a built-in smartphone camera as a source to send and receive data. Designed to provide fast, easy, and convenient wireless connectivity, it is already being used for contactless payments, virtual event tickets, access control, and information sharing between smartphones. This comprehensive study will be a valuable guide for researchers and academicians as well as for the business world interested in NFC technology and its applications.

Keywords: Near field communication (NFC), Light Fidelity (Li-Fi), Visible Light Communication (VLC), Data Communication.

Introduction

In present days, a new communication technology known as Near-field communication (NFC) is becoming popular in mobile smartphones. This technology needs two NFC-compatible devices placed very near to each other (less than 4cm) to communicate. NFC operates at 13.56 MHz and can transmit International Journal on Cybernetics & Informatics (IJCI) Vol. 4, No. 2, April 2015 134 information up to a maximum rate of 424 Kbits per second [3]. In an NFC communication, two devices are needed. The first device is called the initiator which is an active device and is responsible for starting the communication, whereas the second device is called the target and responds to the initiator's requests. The target device may be active or passive. The communication starts when the active device gets close to the target and generates a 13.56 MHz magnetic field and powers the target device [3, 4] (See Figure 1). The NFC technology works via magnetic field induction and operates on an unlicensed radio frequency band. Also, it includes an embedded energy source component whereas the target can be an RFID card, tag, or an NFC device that gives the reply to the initiator's request [1]. An NFC-enabled

smartphone uses an NFC controller chip connected to an NFC antenna. The controller chip can be defined as a specialized Central Processor Unit which accepts instructions provided by the application processor software and then processes those instructions to complete the NFC tag detection and/or reading NFC tag content [8].

Li-Fi is a wireless communication technology that uses visible light to send data at high speed between devices. In the most recent years, studies on Visible Light Communication (VLC) are conducted to overcome radio spectrum congestion. The process behind Li-Fi is to transfer data at high-speed using light waves from any light source even the ordinary light table. Li-Fi can be considered as an optical version of Wi-Fi so that instead of using radio waves to transfer the data it uses visible light [2]. Professor Harald Hass, the chair of Mobile Communications at the University of Edinburgh, institute Li-Fi; demonstrated a Li-Fi prototype at the TED Global conference in Edinburgh on 12th July 2011. He illustrated the ability to use Light Emitting Diodes (LEDs) for data transmission [6].

Figure 1: NFC Enabled Smartphone diagram [8]

Literature Survey

In paper [1], A. Rahul et. Al. states that the NFC protocol needs standardization to be accepted by the industry for commercialization and provide for compatibility between the devices produced by different vendors. Standardization means keeping the specifications open and stable, and accessible for everyone, also facilitating the protocol analysis and device adaptation for various purposes. The standards are published by ECMA International and ETSI standards. The three standards ISO/IEC 14443 A, ISO/IEC 14443 B, and JIS X6319-4 are RFID standards that have been prompted by different companies (NXP, Infineon, and Sony). ISO-IEC Protocol ISO/IEC 14443 is a series of international standards used for international interchange that describes the parameters for identification cards as described in ISO/IEC 7810. Protocols used by upper layers and by applications that are used after the primary phase is detailed in ISO/IEC 14443-4. ISO 15963.

In paper [17], X. Wu et. Al. states that Using light waves as signal bearers, this relatively new technology can exploit the vast optical spectrum, nearly 300 THz. LiFi access points (APs) can be integrated into the existing lighting infrastructure, realizing a dual-purpose system that provides illumination and communication at the same time. Recent research demonstrates that with a single light-emitting diode (LED), LiFi is capable of achieving peak data rates above 10 Gbps.

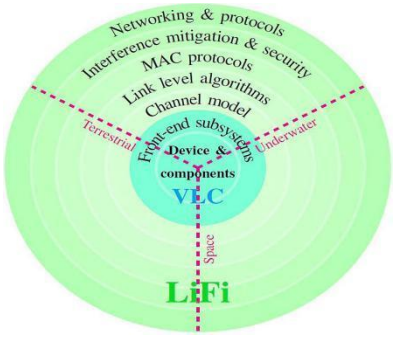

Figure 2: The key elements of Li-Fi and its application areas [11].

In paper [13] V. Coskun et. Al states that NFC technology benefits from various elements such as smart cards, mobile phones, card readers, and payment systems. Following this, all of the proposed candidates need to acquire accreditation from an assortment of governing bodies that have the responsibility for controlling the security and interoperability of NFC devices. The common vision of all standardization bodies is increasing the ease of access, interoperability, and security for NFC technology. Up to now, NFC Forum provided diverse specifications for the various components of NFC technology such as LLCP (Logical Link Control Protocol), NFC Tag Types, NFC RTDs (Record Type Definitions), and so on. Hence NFC literature does not include a high amount of research issues in terms of communication essentials; thus, some experimental and performance testing studies can be conducted. The three NFC communication modes are defined based on which NFC device is paired and performing communication with NFC mobile. The communication protocols, standards, etc. differ for each operating mode.

Near Field Communication with Light Fidelity

In this section, the block diagram of the Li-Fi system is described. In Figure 3 there are two sections: transmitter and receiver. On the transmitter side, the data is first converted to binary through an ADC

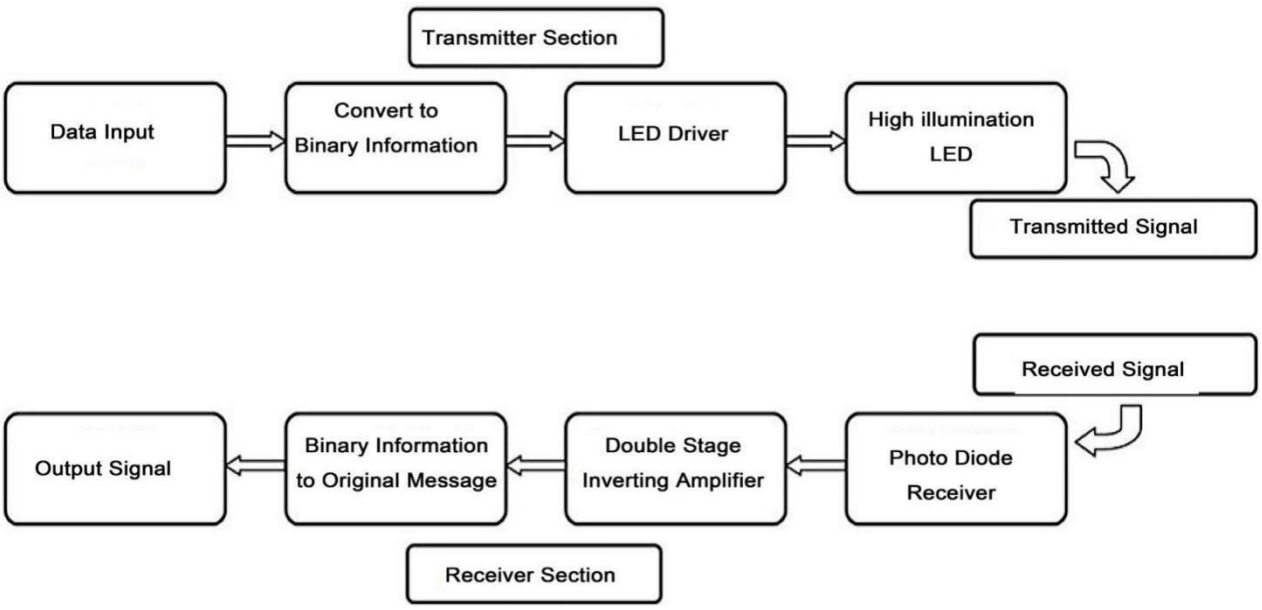

Figure 3: Basic block diagram of Li-Fi system [9]

and then fed into a LED driver circuit which is controlled by a signal processor. The LED driver works on the On-Off Keying modulation [6]. After this, the high illumination LED blinks at high speed and transmits the data as optical pulses through the wireless channel. On the receiver side, these optical pulses are interpreted by a photodetector into an electrical signal which is amplified by a transimpedance amplifier and then converted back to binary data using a comparator. The LED lights will be networked, so multiple users can access data using a single LED light or move from one LED light to another without affecting their access.

Proposed System Design

The proposed system consists of two parts; the transmitter part and the receiver part. The transmitter part contains a light source, which is an LED flash of a built-in smartphone camera that is used to transmit data. While the receiver part is composed of a light detector sensor, which is used to detect the light signal and convert it to original data. Initially, the proposed model investigates how the smartphone built-in light sensor can be utilized to implement a smartphone to a smartphone communication system based on VLC, then figures out if the data rate achieved by this type of communication is approved by the expected Li-Fi 's throughput. Later, the external light sensor was examined to demonstrate how to improve the data bit rate [5].

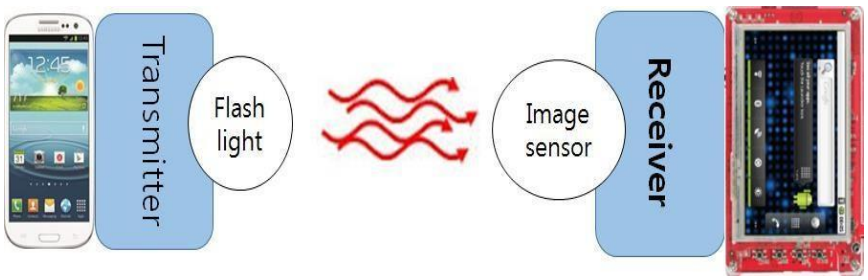

Figure 3: System Architecture [14]

Android platform device was used for this study. As shown in Figure 1, the transmitter for visible light communication sends a binary signal by turning on/off data using flash, and the receiver gets a binary signal by detecting the on/off of light by using the image sensor of the camera. A flash-light Android application is to be developed for the transmitter which is designed to be on and off when the binary is '1' and '0' respectively and Android-NDK for converting on/off signals to binary code '1' and '0' according to the strength of light and application for displaying them on Android Platform were developed for the test [14].

Conclusion

Apart from saving the world from the dreaded spectrum crunch, LiFi offers multiple advantages. Revolutionary speed: Digital signals carried by light are way faster than those transmitted via radio waves used in WiFi connections. Some companies have tested LiFi, and they've projected it to be up to 1000 times faster than WiFi. To paint a clearer picture, LiFi can transmit 224GB of data per second. At that rate, you can download a high-definition video in just a matter of seconds. Top-notch efficiency: LiFi uses a LED light bulb as a medium to transmit data to and from a device. Better security: Radio waves can pass through walls, so people outside your WiFi network can intercept them. Enhanced

availability: With LiFi, you can connect to the internet as long as there's a LED light source. Of course, there are a few drawbacks to using LiFi. For one, it has a limited range. [10]

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